Journal of the Kansas Entomological Society

(Central States Entomological Society)

Vol. 27 October, 1954 Number 4

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Entered as second-class matter June 7, 1939 at the Post Office at Manhattan, Kansas, under the Act of August 24, 1912.

JOURNAL OF THE KANSAS ENTOMOLOGICAL SOCIETY

A quarterly journal published in January, April, July, and October devoted to Entomology in the Western Mississippi Basin and the proceedings of the Kansas Entomological Society.

Manuscripts for publication may be sent to the Editor, Mary H. Michener, care of Department of Entomology, University of Kansas, Lawrence, Kansas or to any member of the publication committee.

The Kansas Entomological Society does not make exchanges since the Society does not maintain a library.

Subscriptions to the Journal must be paid in advance. The subscription rate is so low that second notices are not ordinarily sent out.

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Canadian or foreign subscriptions,	**$2.25 per year**	**75 cents**

KANSAS ENTOMOLOGICAL SOCIETY

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Vol. 27, No. 4, October 1, 1954

This issue mailed October 27, 1954

Kansas Entomological Society
Vol. 27 October, 1954 Number 4

STUDIES IN NEW WORLD DORILAIDAE (Pipunculidae:Diptera)

by

D. Elmo Hardy[1]
Honolulu, Hawaii

The following notes and descriptions have been accumulated over a number of years. I am indebted to Dr. R. H. Beamer, University of Kansas, and to Dr. Martin Aczel, University of Tucuman, Argentina, for the loan of most of the specimens discussed in this paper. The drawings have been made by Marian S. Adachi, University of Hawaii.

Dorilas (Dorilas) plaumanni n.sp.
Figs. 1a-d

This species very closely resembles *Dorilas (Eudorylas) doelli* (Shannon). The presence of the fan of hairs on the propleura as well as the more darkly fumose wings will readily separate it.

Male. Head: The junction of the compound eyes is approximately one and one-half times longer than the lower portion of the front. The front is densely gray pubescent except for a shiny black spot in the median portion of the swollen area. The face is distinctly narrower than the front; it is approximately three fourths as wide as that portion of the front just above the antennae. The basal two segments of the antennae are yellow, tinged with brown. The third segment is yellow. The second segment has two or three long ventral setae which extend beyond the apex of the third segment. The third segment is short, acute to obtuse at the apex (fig. 1a). The occiput is almost entirely gray pubescent, very slightly tinged with brown on the upper portion. *Thorax:* Brown to black in ground color; densely covered with yellow-brown pollinosity on the dorsum and gray on the sides. The humeri and halteres are yellow and the pleura are tinged with yellow to rufous. The thorax is devoid of any conspicuous hairs except for the fan on each side of the propleura. The hind margin of the scutellum has a row of fine inconspicuous setae. The hairs of the propleural fan are white and are very short. *Legs:* Yellow to rufous; flexor spines are moderately developed on all femora. The hind tibiae have no well developed bristles on the outside surface of the swollen portion and the front and middle tibiae have no apical spurs. *Wings:* Rather strongly brownish tinged. The stigma is dark brown and fills all of the third costal section; the third section is approximately equal in length to the fourth and the two sections combined are much longer than the fifth section. The r-m crossvein is situated at the basal third of cell 1st M_2 and the last section of vein M_{1+2} is strongly curved (fig. 1b). *Abdomen:* Black in ground color and entirely opaque; the first tergum is densely covered with

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yellow-brown pollen and has a row of three to four moderately strong brown bristles on each side. Terga two to five are velvety black on the basal one-half to three-fourths and are yellow-brown pollinose on the sides and on the apical portions. The abdomen is almost straight sided, being just slightly broadest at about segment three, and is sparsely covered with short, yellowish pile. *Genitalia:* About three-fourths as long as the fifth abdominal segment with a conspicuous apical membranous portion and a cleft at the base on the right side (fig. 1c). From a ventral view the membranous portion bisects the eighth segment for about one-half its distance. The claspers are about as long as the ninth segment, are curved and attenuated at their apices, slightly overlapping one another (fig. 1d).

Length: Body, 3.5-3.8 mm.; wings, 4.5-5.0 mm.

Female unknown.

Holotype male, and three paratypes, Nova Teutonia, Brazil, 27° 11′ N., 50° 23′ W. August-Sept., 1948, Fritz Plaumann.

Type and one paratype returned to Dr. Martin Aczel, University of Tucuman, Tucuman, Argentina. One paratype is being deposited in the United States National Museum, and one is at the University of Hawaii.

Dorilas (Eudorylas) arundani n.sp.

Figs. 3a-c

Dorilas minor cressoni Hardy (*nec* Johnson), 1945, Univ. Kans. Sci. Bul. 29(1):104.

I had previously considered this to be *D. cressoni* (Johnson) but after examining material from Jamaica I have concluded that they are not the same. I also had considered *cressoni* as a subspecies of *D. minor* (Cresson) but it now appears that these are distinct species.

D. arundani is closely related to *minor* and is distinguished by having the sides of the abdomen tinged with yellow to rufous, in the females the sides are often bright yellow; by the all yellow femora, and by the striking differences in the male genitalia as shown in figures 3a and 4. As seen from a dorsal view the male genitalia of *arundani* have a small keel in the middle of the membranous area; this is not present in *minor*. Segments seven and eight are fused together. The inner clasper tapers rather gradually to the apex in *arundani* (fig. 3a); not with a parallel-sided apical lobe as in *minor* (fig. 4). The sixth tergum of *arundani* is distinctly shorter than the length of the fused seventh and eighth segments and is wider than long. At the apical margin it is less than one-half as wide as the ninth segment and less than one-fifth as wide as the fifth segment. (fig. 3a). In *minor* segments seven and eight are separated, the sixth tergum is greatly developed, is equal in length or longer than the combined lengths of seven and eight, is about as wide as long, and approximately equal in width to segment nine and on its posterior margin it is nearly one-half as wide as the fifth segment (fig. 4).

Male. Head: The junction of the compound eyes is about equal in length to the frontal triangle. The front is silvery on the sides and on the upper portion and is gray pubescent in the center. The face is about equal in width to the lower portion of the frontal triangle. The first two antennal segments are brown to black; the third is bright yellow and is moderately long acuminate

(fig. 3c). The occiput is entirely cinereous except for faint brownish pollen on the upper portion. *Thorax:* Entirely opaque, brown on the dorsum and gray on the sides. The humeri are yellow, the halteres are tinged with brown on their apices. *Legs:* Almost entirely yellow, only the coxae and the apical subsegments of the tarsi are brown to black. The femora are slender, conspicuous flexor spines are developed only on the middle pair. The hind tibiae possess no strong erect bristles on the outside surface. *Wings:* Hyaline, the third costal section (stigma) is equal or slightly longer than the fourth; the third and fourth sections combined are about one and one-third times longer than the fifth. The r-m crossvein is situated at the basal one-third of cell 1st M_2 and the last section of vein M_{1+2} is straight. The last section of vein M_{3+4} is equal in length to the m crossvein. *Abdomen:* Chiefly brownish pollinose on the dorsum, gray on the sides, with a narrow gray vitta extending along each posterior margin. The ground color is brown to reddish brown on the dorsum, yellow to rufous on the sides and on the venter. The sides of the abdomen are rounded, it is widest at the junction of segments three and four. The first tergum has two or three short black bristles on each side. *Genitalia:* Brownish red to yellow-brown in ground color, rather symmetrical in shape, approximately as long as the fifth abdominal tergum with a conspicuous apical membranous area and a small keel in the middle of the membrane. (fig. 3b). From a ventral view the genitalia are as shown in figure 3a and as described above under the comparison with *D. minor.*

Length: Body, 3.5 mm.; wings, 4 mm.

Female. Front about equal in width to the face and slightly extended in the median portion. The front is predominantly gray pollinose, and is sub-shining black just below the ocellus. The abdomen is more consistently yellow to rufous than in the male, especially on the sides. In the allotype segments one and two are entirely yellow and the other segments are yellow on the sides and on the venter. *Ovipositor:* Poorly developed and inconspicuous, very similar in size and shape to that of *D. minor.* The basal portion is yellow-brown and the piercer is yellow. The piercer is straight, is about equal in length to the base and extends scarcely beyond the apex of the fifth abdominal segment. The sixth tergum is extended to the venter of the abdomen and acts as a protective sheath in which the ovipositor fits. The basal portion of the ovipositor has a small tubercle below and a slight median concavity above. Otherwise fitting the description of the male.

Length: Body, 3.0-3.3 mm.; wings, 3.3-3.5 mm.

Holotype male, Griffin, Georgia, August 12, 1939 (R. H. Beamer). Allotype female, Adel, Ga., Aug. 11, 1939 (R. H. Beamer), and three paratypes, two males and one female, same locality and date as type (R. H. Beamer and D. E. Hardy). All taken sweeping *Arundinaria* (wild cane) and were associated with leafhoppers of the genus *Arundanus.*

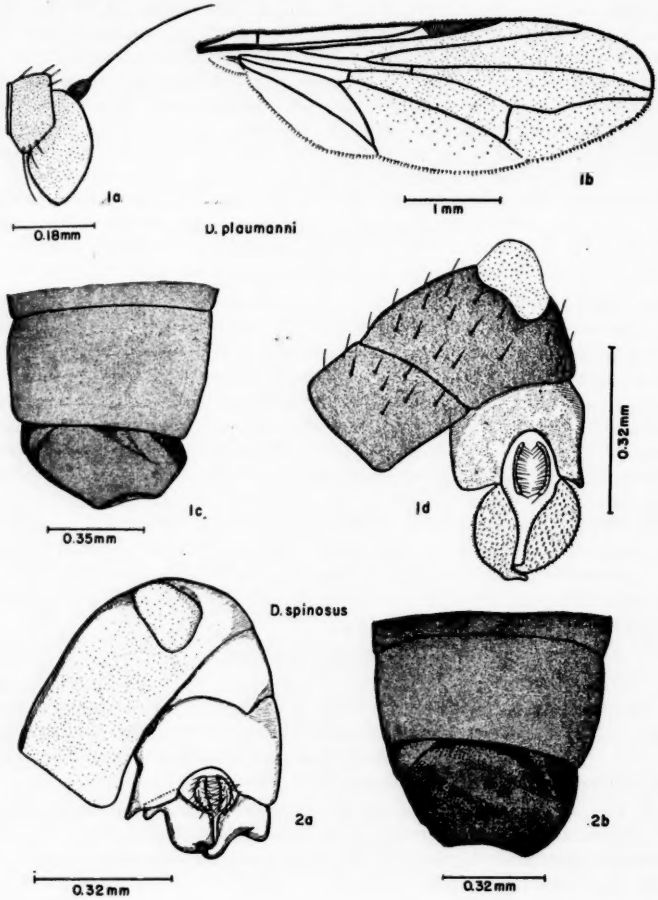
The type, allotype, and one paratype have been returned to the Snow Entomological collection, University of Kansas. One paratype is being deposited in the United States National Museum, and one paratype is being retained at the University of Hawaii.

Dorilas (Eudorylas) cressoni (Johnson)

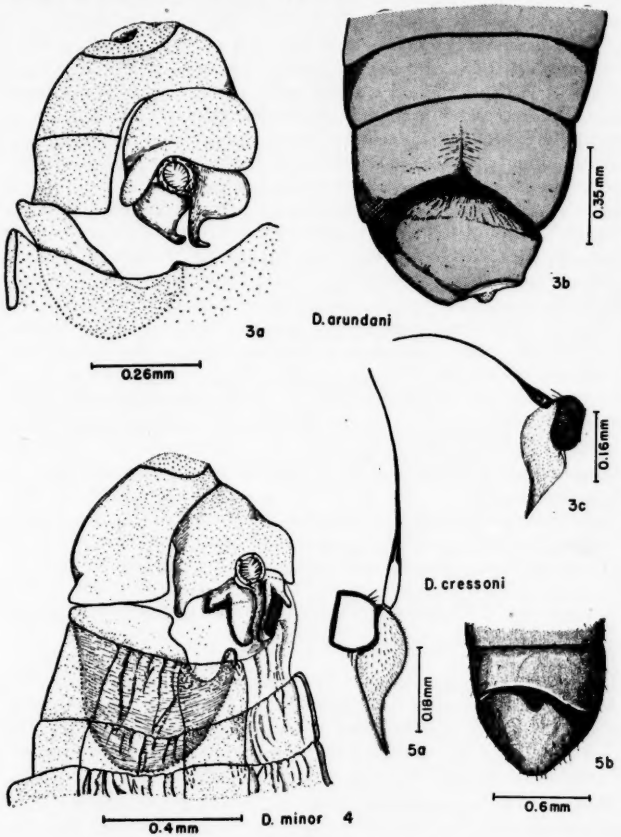
Figs. 5a-b

Pipunculus cressoni Johnson, 1919, Bull. Amer. Mus. Nat. Hist. 41:433.

This species is related to *D. rubidus* Hardy and is distinguished by having the third antennal segment gradually tapering at the apex, not setiferous; the third section of the costa equal in length to the fourth and the r-m crossvein situated at the basal one-third of cell 1st M_2. It is distinguished from *D. arundani* n.sp., by the absence of a membranous area on the male genitalia, by the presence of a basal cleft (fig. 5b), by the presence of erect bristles on the tibiae, as well as in other details.



Male. Head: Junction of the compound eyes about equal in length to the front below the junction. Front and face silvery pubescent. Occiput brown on upper portion, cinereous on sides and below. Mouthparts and antennae bright yellow, bases of aristae yellow. Bristles of second segment very short and yellow. Third segment long acuminate but not developed bristle-like at



EXPLANATION OF FIGURES

1. *Dorilas (Dorilas) plaumanni* n. sp. a. antenna; b wing; c. genitalia, dorsal; d. male genitalia, ventral.
2. *D. (Eudorylas) spinosus* Hardy. a. male genitalia, ventral; b. male genitalia, dorsal.
3. *D. (Eudorylas) arundani* n. sp. a. male genitalia, ventral; b. male genitalia, dorsal; c. antenna.
4. *D. (Eudorylas) minor* (Cresson). male genitalia, ventral.
5. *D. (Eudorylas) cressoni* (Johnson). a. antenna; b. male genitalia, dorsal.

the apex (fig. 5a). *Thorax:* Chiefly black in ground color, dorsum brownish pollinose, sides gray. Humeri, tegulae and halteres yellow. Propleura bare, scutellum with a few short, inconspicuous marginal hairs. *Legs:* Entirely yellow, femora slender, flexor spines weak. All tibiae with a row of three or four short erect bristles on the outside of the swelling, these are not strongly developed but do stand out from the other recumbent bristles of the tibiae. *Wings:* Hyaline, stigma light brown filling all of the third costal section. Third section equal in length to the fourth, the two combined are just slightly longer than the fifth section. The r-m crossvein is situated at the basal one-third of cell 1st M_2 and the last section of the fourth vein is almost straight. The m crossvein is longer than the last section of the fourth vein and the appendix of the cubital cell is about as long as the r-m crossvein. *Abdomen:* Shining yellowish red to blackish in ground color, lightly dusted with gray on the sides and brownish gray on the dorsum. Sides of abdomen almost straight, slightly wider at the junction of segments three and four. Entire venter and all of terga one to three yellowish red. Tergum four chiefly rufous with dark discolorations along hind margin. Fifth tergum black except for narrow yellow lateral margins. Seventh tergum yellow, just slightly visible from a dorsal view. First tergum with two to three short dark bristles on each side, abdomen otherwise very sparsely haired. *Genitalia:* Entirely dark reddish in color, rather symmetrical in shape with no membranous area but with a basal cleft on the right side (fig. 5b). From a dorsal view it is slightly longer than the fifth abdominal segment. The claspers appear to be broad, short and rounded at apices, they are folded downward into the genital chamber in the specimen at hand.

Length: Body, 3.0 mm.; wings, 3.2 mm.
Female unknown.
Type locality: Montego Bay, Jamaica.
Type in the Museum of Comparative Zoology.
I have studied a paratype from Liguanea Plain, Jamacia.

Dorilas (Eudorylas) spinosus Hardy

Figs 2a-b

Dorilas (Eudorylas) spinosus Hardy, 1948, Psyche 55(1):4-5, Figs. 3a-c.

This species is recognized by its predominantly polished black abdomen, moderately long, acuminate antennae and by the strong apical spurs on the front and middle tibiae; also by the genital characters of both sexes. The species has previously been known only from the females. The two sexes have now been associated and the male is described below.

Male. Fitting the description of the female (loc cit.) except for secondary sexual and genital characters. The eyes are joined on the front for a distance about equal to the lower portion of the front; the frontal triangle is densely silvery gray pubescent. The face is densely gray and is slightly wider than the front. The vertex and upper occiput are brown pollinose, otherwise the occiput is gray. Abdominal terga three to five are all polished except for a narrow, opaque brown to black band at the bases. *Genitalia:* Entirely opaque grayish brown; the visible portion is almost as long as the fifth abdominal segment; is rather symmetrical in shape and has a moderately large mem-

branous area at the apex; this is not visible in direct dorsal view (fig. 2b). A small basal cleft is present on the right side of the genitalia. From a ventral view the membranous portion is rather narrow and occupies the apical portion of the eighth segment. The ninth segment is slightly longer than wide and is rather sharp pointed on its posterior lateral margins. The claspers are very short and broad; they are scarcely longer than wide and are irregular in shape; the outer clasper is bilobed with the inner lobe rather elongate and curved inwardly at its apex. The inner clasper has a large, blunt apical lobe and a small partially hidden basal lobe (fig. 2a).

Eleven specimens are on hand from Nova Teutonia, Brazil, 27° 11′ N., 50° 23′ W., Dec. 1944 to April 1950, Fritz Plaumann.

Type locality: Costa Rica. The type is in the Museum of Comparative Zoology.

Tömösváryella lepidipes Hardy

Tömösváryella lepidipes, Hardy, 1943, Univ. Kans. Sci. Bul. 29(1):166-167. pl. 16, figs. 92a-e.

Specimens on hand from Brazil appear to be identical with those from the United States. The species is closely related to *T. tuberculata* Hardy (1948 Psyche 55(1):11-12, figs. a-d) from the Neotropical region and is distinguished by lacking the broad membranous area extending over the dorsum of the eighth segment of the male and by the smaller, more poorly developed tubercle on the underside of each hind trochanter.

Type locality: Fallen, Nevada.

Type in the Snow Entomological Collection, University of Kansas.

This species is widely distributed over the United States and obviously occurs throughout much of the Neotropical region. The only known host record for it is *Colladonus germinatus* (Van Duzee). It has been reared from this leafhopper at Logan, Utah, by G. H. Kaloostain and by M. W. Nielson at The Dalles, Oregon. Mr. Kaloostian said that parasitism of this leafhopper by these flies runs high during the fall of the year.

The four specimens on hand from the Neotropics are from Nova Teutonia, Brazil, 27° 11′ N., 50° 23′ W., March-April, 1950 (Fritz Plaumann).

OBSERVATIONS ON THE BIOLOGY OF *COMPERIA MERCETI* (Compere), (Hymenoptera:Encyrtidae)[1,2]

FRED A. LAWSON[3]

The presence of an encyrtid parasite of the Brown Banded roach, *Supella supellectilium* (Serv.), has been known in Manhattan for some time. This minute wasp has been collected widely in the temporary student housing buildings as well as in various types of structures in the city's residential area. It apparently is permanently established and widely distributed in this locality. Ft. Riley is considered the most likely avenue of introduction of this wasp; it evidently arrived here in the immature stages within parasitized host egg cases.

The wasp is a member of the subfamily Encyrtinae, family Encyrtidae. It was described originally by Compere (1938) as *Dicarnosis merceti* but with the following qualifications: "It is strongly suggested that both" [*Dicarnosis*] "*alfierii* and the new species [i.e., *merceti*] "are incorrectly placed generically and that eventually a new genus must be made for their reception." Gomes (1942) placed *merceti* in a new genus, *Comperia,* and at the same time listed *falsicornis* as a variety. The latter is considered synonymous by Muesebeck et al. (1951).

The distribution of this insect is listed as Florida and Texas by Muesebeck et al. (1951). The range has probably been extended to numerous other localities, especially in the vicinity of military installations. It is strongly suspected that *Supella supellectilium* was given widespread distribution through movement of military personnel and materials and it does not appear unreasonable that the parasite followed its host.

The hosts listed by Muesebeck et al. (1951) are *Blattella germanica* (L.) and *S. supellectilium* (Serv.). No new hosts are reported in the present paper; unsuccessful attempts were made to rear the wasps on eggs of *Blatta orientalis* (L.) and *Periplaneta americana* (L.). Oviposition did not occur in these more thickly walled oothecae. The German roach was not available in sufficient numbers to permit use of its eggs for rearing the parasite.

ADULT HABITS

The adults of *C. merceti* are minute and black-bodied but have a distinctive white band in the middle of the antennal flagella. They are strongly attracted to light and are most often found on or near windows. Also, a strong flea-like jumping tendency is usually displayed. This is most often observed in males and in females not engaged in oviposition. Both sexes typically walk about over windows or nearby woodwork or furniture, pursuing an erratic

1. Contribution No. 616, Department of Entomology.

2. The writer is greatly indebetd to the following persons: Dr. R. H. Painter, who suggested first the parasite-host relationship and supplied the wasps for the first colonies: Mr. C. F. W. Muesebeck and Dr. R. D. Burks of the U. S. National Museum for making the determinations; Mr. F. J. Hanna for photographing the egg-laying female; and Dr. P. A. Dahm for the use of an air-conditioned rearing room.

3. Assistant Professor of Entomology, Kansas State College, Manhattan, Kansas.

course and continually touching the surface with the tips of the antennae. Since the eggs of the host roaches are usually placed in the darker parts of cabinets, closets, and furniture, the strong affinity of the adults for light raises some question as to the insect's relative efficiency as a biological control. This should be more of a factor in summer when windows and doors are open and the wasps are taken outside by their phototropic response.

REARING METHODS

Specimens were at first collected from around the windows and confined in 10 dram patent lip vials for oviposition. Cotton plugs were used as stoppers after it was found that corks were conducive to host egg spoilage. When the wasp colony was well established, the adults were transferred directly from the holding vials to others containing newly gathered roach egg cases. Host eggs were taken from a maintained stock culture. Various food materials included in each vial with the new oothecae apparently did not affect adult longevity and did not interfere with egg deposition.

OVIPOSITION

When a choice was possible, the oothecae chosen by the females for oviposition were at least approximately two weeks old; a majority of all the eggs observed were placed in such capsules, in which the color and rigidity of the walls were fully developed. Eggs were placed, however, in oothecae a week or less old, as well as in those well advanced into the green band stage. As many as three female wasps were observed ovipositing in one capsule of intermediate age, even though a dozen or more of mixed age were available. The total number of eggs placed within different capsules likewise varied; fifty or more, based on counts of egg stalks, were placed in some capsules while others received few or none. It was not possible to expose oothecae of known age in days. As a result of selective habits, only about 50% of the exposed oothecae were parasitized.

Wasps taken on windows frequently were ovipositing within minutes after being caged with eggs; actual recorded times in this regard were 3, 5, and 10 minutes after introduction. Otherwise a variable period of exploratory walking and antennal probing was observed. Colonized adults were usually more deliberate in begining oviposition; in these the response was not quick enough to allow exact timing but periods of 4 to 24 hours between introduction and oviposition have been observed. A preoviposition period of undetermined duration, some of which may be passed before emergence from the ootheca, is suggested.

The movement within the cage and over the egg cases is rapid and aimless until an interest in oviposition becomes evident. Then the wasp slows her pace and appears to tap and feel the oothecal walls with considerable care. All sides of the egg capsules are explored before a tentative site is chosen. At this time the forward motion ceases and the body is raised and lowered by flexing the legs at the femoro-tibial joints. The abdomen is then bent downward and slightly forward. As this position (Fig. 1) is assumed, the antennae are brought together and the basal portion is pointed straight ahead; the scapes are held horizontally and frequently in distal mesal contact. The flagellum is

directed back toward the face and downward below the lower margin of the head. The antennae remain quiet and in this position during oviposition.

The ovipositor sheath is clothed apically by long, slender hairs, which evidently serve a sensory function. The sheath is repeatedly touched to the surface of the ootheca prior to exsertion of the ovipositor, bringing the hairs into close and nearly continuous contact with the surface of the capsule wall. The exploratory tapping action of the sheath very often follows a circular or rotating sequence; this consists of a body movement imparted by a rocking motion in the legs to the left, backward, and around into the original position. The sheath is touched to the host surface many times during this series of motions. This activity usually is of short duration, with only three to five circles being completed each time. A pause occurs between cycles of movement, during which the female may either remain stationary or move to another location.

The sheath evidently selects the oviposition site and the ovipositor then is quickly disengaged and left in position perpendicular to the oothecal surface (Fig. 1). The sheath then extends backward at about a 45° angle with the vertical. This is termed the ovipositing position even though the angle may increase when the abdomen is lowered while driving the ovipositor deeper into the egg case. On many occasions the ovipositor remained unsheathed for a time, only to be reincased, after which the sequence of rotary rocking and sheath tapping was repeated.

FIG. 1. *Comperia merceti* ovipositing

In one vial the oothecae were accidentally juggled into contact with one wasp; she stopped and stood almost perfectly still for approximately 30 seconds, then turned and walked to a capsule, mounted it, and immediately began probing with the antennae. The sheath response came seven minutes later, including a one-minute period during which she was accidentally shaken from the egg case. During this period of separation from the capsule the insect stood quietly and rubbed the scapes of the antennae together; she then turned and walked directly back to the egg case. The ovipositor was unsheathed again, after about one minute, and penetration of the egg case wall was attempted. The site chosen apparently was unsatisfactory, for the ovi-

positor was seen to buckle slightly in the middle as pressure was applied. Another accidental movement of the vial caused the wasp to interrupt the oviposition attempt, sheath the ovipositor, and leave the ootheca. Penetration of the wall had not been achieved. Typical sheath-tapping responses were not observed again for ten minutes.

Puncture of the relatively thin capsule wall usually is rapid and apparently quite easy. As the stylets are applied to the surface, a rapid pumping motion starts in the abdomen and the whole lower abdominal surface pulsates rapidly. This fast action on the part of the abdomen may aid in driving the stylets through the oothecal wall and the underlying chorion and into the host egg. A drop of clear exudate from the punctured egg seeps out and surrounds the stylets at the surface level. This may stick to the stylets near the top when the wasp thrusts deeply into the egg. The abdomen pulsates rapidly and continuously for a short time after the egg has been punctured. This movement then diminishes for a while but is resumed as the actual time of deposition approaches.

The stylets of the ovipositor are in almost constant motion during much of the time of insertion. This action consists of two distinct types of movement. The most noticeable is a counterclockwise rotation of the blades through what appears to be a half to a three-quarter turn but which may sometimes be almost a complete turn; the second is a rapid vertical movement of the styles operating either simultaneously or independently. These actions are verified by observing the changing positions of bits of debris which become attached to the stylets and which accompany them in all their activity.

A series of very rapid pulsations of the abdomen foretells and accompanies the actual deposition of the egg. These actions continue, though somewhat abated, as the egg is passing down the channel. The ovipositor at this time is driven to about half its depth into the capsule and much of the rotary motion of the stylets is stopped. The blades are held in position while the pumping motion continues. As the egg passes quickly down the stylets, it is seen as a flow of shadowy, granulated, jelly-like protoplasm; there is no evident bulging of the stylets during passage of the egg, which indicates that during deposition the egg substance is squeezed into a long thin strip. The moment of deposition can be observed when strong indirect light is shining through the rather transparent ovipositor blades. The descent of the egg is stopped and the stylets are withdrawn until only the tips are engaged when the egg has reached the level at which the stalk will be formed; the stalk is a respiratory structure which will be discussed further in the description of the egg. At this point the stalk is observed as a very narrow line of protoplasm up the front edge of the ovipositor blades; it very quickly turns milky and becomes more distinct. If the egg is the only one or the last to be laid in a given puncture, the stylets are withdrawn and quickly snapped backward, disengaging the stalk and leaving it upright. If additional eggs are to be placed within the same puncture, the stalk of the first and of succeeding (but not the last) eggs are pushed out of the stylets and curve downward and away from the ovipositor. This perhaps is accomplished by the approaching margin of the next egg to be deposited. The rotating stylets frequently snag and break off the stalk of the first (and later) eggs and rotate them along with other

debris; this causes a stalk count to be a poor criterion for estimating the number of eggs within a given ootheca. It evidently does not interfere with the normal development of the destalked egg.

When the last egg is placed in a puncture, the ovipositor is withdrawn, the hind legs are lifted and the tibiae are passed in quick succession along the ovipositor. The posterior, distally curved spines serve as a comb which quickly and efficiently cleans the ovipositor. In one specimen the debris was cleared away by the right rear tibia, to which it clung for some time.

In one case the stylets were withdrawn and freed from the stalk after the first egg had been deposited but the wasp probed with the sheath until the puncture was again located. The stylets were inserted into the same puncture and other eggs were deposited; all stalks except the last were broken off by the action of the stylets.

There seems to be a definite tendency for the wasps to choose a nearly horizontal position for egg laying. This was observed most often in those instances in which only a few eggs per capsule were deposited; the result was a concentration of eggs on the sides of the capsule if the latter were sitting upright, or along the distal (curved) margin if the capsule were lying on one side. Eggs were laid in numerous cases, however, on the top surface of the ootheca (the wasp was standing upright) and it is uncertain whether or not there is any definite preference for oviposition sites. Where numerous eggs were deposited, the distribution was general over the entire exposed surface.

It is not possible to determine the exact number of eggs deposited by individual wasps; this part of the biology is complicated by the stalk removal factor mentioned above. When wasps were caged individually and observations made on the punctured oothecae, the results of stalk counts seldom agreed with the number of eggs or larvae which later were dissected out. Also, the number of offspring from such individual cagings varied from as few as five to as many as twenty-five per wasp. A rough estimate, based on counts of punctures, dissections of capsules, and dissections of gravid females, is in the proximity of 20 per female.

The number of punctures, which can indicate from one to three eggs each, varies from one to fifty per capsule. In two different instances the egg cases chosen for deposition by a group of wasps showed approximately fifty punctures each. These were thickly spread over the sides and around the back surface to as far as the wasps could creep under and still be able to place the eggs.

The puncture of the capsule wall is usually indicated by at least one stalk standing upright from the surface; this is white in color and quite prominent once it has been located. After a day or two a black spot shows through the egg case walls and surrounds the punctures; there is a slight increase in size as the spot assumes an irregular outline. If stalks are absent the black spot can be used as a means of locating the position of the eggs. The eggs are sometimes vaguely discernible through the oothecal wall.

DESCRIPTION OF STAGES

Ovarian egg. The eggs of this insect are encyrtiform, according to the classification of Clausen (1940). An egg as dissected from the female wasp is

double, which is typical of many species of the family. It is composed of two bulbs connected by a thin neck or constriction (Fig. 2). The two bulbs are of differing sizes; the larger, which bears a broad, granulated plate, eventually is squeezed through the ovipositor into the host egg (Fig. 2, *ap*). The smaller may only be an enlarged area of the neck into which surplus ovarian cytoplasm flows when it is squeezed into the delivery channel of the stylets. The larger (the egg) is reinflated once it is in position within the roach egg; the smaller is collapsed and its identity mostly lost as oviposition is finished (Fig. 3, *cb*). The contents of this bulb, according to Clausen (1940), may be forced into the larger one (the egg proper) during oviposition with the emptied membranous outer integument becoming a hollow tube-like upper part of the stalk. The latter have been observed in eggs of this species.

Deposited egg. The newly placed egg averages about .22 to .24 mm. in length and about .06 mm. across at the point of greatest width. It is elongate oval, translucent whitish, and has a smooth, shining surface. The stalk described previously (Fig. 4, *st*) suspends the egg from the oothecal wall; the inside portion of the stalk measures about .06 mm. while the outside segment (Fig. 3) may be about 0.1 mm. long. The inside stalk is continuous with a thickened, expanded aeroscopic plate (Fig. 4, *ap*) which caps one end and extends along about three-fourths the length of one side of the egg. This plate, which continues along the stalk to the exterior (Fig. 3, *ap*), serves as the respiratory connection for the egg and later for the first instar larvae.

The end which is capped by the plate eventually is occupied by the caudal extremity of the embryo and then by the same portion of the first stage larva. The surface along which the plate extends is at the same time ventral to the embryo and to the larva. The opposite end eventually is cephalic, while the other surfaces are considered as dorsal and lateral without regard to the actual position within the host egg case.

All surfaces of the egg except the ventral and caudal are evenly and smoothly rounded in profile. The dorsal and lateral profiles are broadly convex; the cephalic is almost round. The ventral margin usually is slightly concave in the mid-region of the egg; this modification apparently is due to the presence and nature of the aeroscopic plate. The plate is composed of denser material which appears to be of rather coarsely granular texture; interstitial spaces appear to be filled with respiratory gases. This structure tapers to a blunt but narrowed termination just beyond the concave area of the ventral margin.

The egg is evenly translucent when first deposited; a somewhat more opaque white area appears in the center of the egg and gradually incrases in size (Fig. 4, *ws*). Most of the interior of the egg is thus occupied just prior to hatching. This is termed the white spot stage and presumably indicates the progress of embryological development.

The egg tends to be more ovate in outline when deposited but becomes somewhat elongate as hatching time is approached. There may be a slight increase in size as the embryo develops.

THE LARVAE

First Instar. This stage, having been derived from an egg of the same type, is classified as encyrtiform. The last abdominal segments are very tightly held

by the egg shell and the larva remains suspended from the capsule wall (Fig. 5, *cw*) by the stalk (Fig. 5, *s*). The egg shell (Fig. 5, *c*) can be seen, under high magnification, as a very thin, wrinkled envelope surrounding the last few segments; the last bears a pair of spiracles which lie low on the body and are closely appressed to the central region of the aeroscopic plate (Fig. 5, *ap*). A pair of tracheal trunks (Fig. 6, *tr*) extends forward through the lower lateral body regions and ends near the head; transverse cross-over tracheae, which are found in all instars, connect the two trunks at the ends of the body (Fig. 11, *aco, pco*). Tracheal stubs branch off from the trunks at regular intervals and extend dorsolaterally toward the surface. They taper down to nothing (Fig. 6, *sps*) before reaching the body wall. However, dimples on the surface indicate the future locations of spiracles.

Body segmentation is notably indistinct. At best only ten or eleven segments can be distinguished and even these frequently are of doubtful identity. External evidence of segmentation consists entirely of minute circular ridges with shallow depressions between; no sutural indications are discernible.

The body is slightly rounded over the dorsal surface as opposed to a nearly straight or faintly concave ventral margin. The lateral outlines taper backward (along with the dorsal line) to form a somewhat slender caudal termination; they round off much more abruptly in front, however. The greatest depth and width are toward the front, more or less in the thoracic-anterior abdominal region.

The head is poorly developed, visible mostly as a rounded, dome-like anterior segment. No definite suture or constriction separates the head from the thorax; it may, however, be retracted completely out of sight within the first thoracic division of the living larva. The most conspicuous cephalic structures are a pair of minute transparent mandibles. (Fig. 13). These are somewhat triangular, are hinged to the head along their bases, and are seated so as to operate back and forth on a horizontal plane when the larval head is directed forward. The tips usually are slightly separated but rarely may overlap to a small extent. The mandibles were kept in almost continuous motion by the live larvae observed.

The other permanent feature of the head is a stiffened though colorless arc which crosses above the oral opening. The sides of this extend backward along the surface of the head as parallel lines. Each is sharply recurved as an outside arc that reaches to about the level of the mandibles. The stiffness is lost at this level but a rather indistinct crease carries the curvature across to the opposing end. The transverse connection between the lower tips of these structures likewise is only a poorly defined fold in the integument. The area thus set off is a broad median "floor" of the head. Muscles evidently attach to the hardened portions of these minute infoldings.

Activity within the larvae indicated the presence and function of a digestive tract although at first very little of it can be seen. The contents of the gut (Fig. 5) and of the body as a whole may be translucent and early in the first larval stage show little of definitive structure. Later, however, the fully distended gut is observed as a sack filling most of the body cavity and connected to the mouth by a relatively long but narrow tube. A simple valvular arrangement apparently is present to prevent peristaltic backflow into this

tube. The filled sac-like part of the gut is more or less bounded on each end by the cross-over tracheal tubes. No caudal tube leading to an anal opening has been observed

Second Instar. The greatest change in larvae in this stage (Figs. 7 and 8) takes place in the respiratory system. The dimples (Fig. 7, *sp*) along each side of the body exhibit a ring-like structure on the surface (Fig. 10) and the tracheal stubs from the main trunks (Figs 7 and 10, *tr*) have elongated to join them. It is presumed that these respiratory units are functional, especially since most of the larvae dissected were found free of the egg shell and aeroscopic plate. At first they are usually found in the immediate vicinity of the egg stalks; later the larvae, especially when numerous in one host egg, work their way through the egg and on into others. Very early a small space is worked out in the host egg cytoplasm and this almost invariably centers beneath the egg stalks. The respiratory needs of the early part of this stage of larva may be derived directly from the oviposition puncture through the oothecal wall or they may be indirectly taken from the supply being furnished the host egg from the egg-case seam by way of the chorion. The larva, when free of the aeroscopic plate, becomes hymenopteriform in nature (Clausen, 1940).

Segmentation is only slightly more distinct than in the previous stage; considerable help is given by the presence of the spiracles. No sutural marks are found. Segments beyond the last abdominal spiracles, however, remain almost indistinguishable. Parts of the first larval exuvium (Fig. 7, *ex*) may be seen early in this stage.

The head of the second instar larva remains smoothly rounded, although it often is held in a deeply retracted position. The upper margin is the least definitely defined, being set off by a non-sclerotic crease or fold. As in the first stage, the median ventral portion of the head bears the only recognizable structures. The mandibles (Figs. 7 and 9, *mn*) and inner pairs of the curved bars are distinctly brown in color and both are better developed. The arch over the undifferentiated stomodeal opening (Fig. 7, *mo*) is browner and wider so that a dark, flattened plate (Fig. 9, *ds*) overhangs the oral aperture. Since the head may be carried in a variety of positions, the mandibles may operate on any plane between the horizontal and the vertical.

The parts of the digestive tract are no more distinguishable than in the first stage, although great activity and a large food mass in the center of the body are observed.

Third Instar. This stage (Fig. 11) is distinctly hymenopteriform in appearance. The ventral surface is usually held fairly straight or with the ends curved slightly downward. The dorsal and lateral surfaces normally present strongly rounded curves with the greatest height (or width) at the posterior thoracic-anterior abdominal region. In the living larvae these body outlines are subject to considerable change due to the peristaltic and locomotor activity.

The integument is smooth, transparent, and very thin; no pigmentation of any sort is seen except around the spiracles and mouthparts. Segmentation is indicated in the same manner as in earlier instars; that of the anterior and posterior ends is usually more distinct than that of the center. The pres-

sure from the fully inflated gut probably flattens the body wall in the center area.

The digestive tract appears mostly as a darker yellowish mass which occupies the center of the haemocoele and extends close to each end of the body. Probably 75% or more of the entire body cavity is thus occupied. The anterior portion of the tube, presumably the esophagous and pharynx, which extends forward to the oral opening, is kept clear of storage materials and in the live insect is in more or less constant motion. The enlarged sac-like storage portion remains quiet except for peristaltic waves which occur at frequent but irregular intervals. A short transverse slit-like crease is present in the proper position for an anal opening but connection with the gut apparently is not established. This is perhaps to be expected since neither fecal nor meconial pellets are found in the capsules from which such larvae are taken. The opening of this connection, and the discharge of the meconium, presumably indicates the onset of the prepupal period.

Nine pairs of spiracles open on the surface. Each minute spiracle is surrounded by a faintly sclerotic ring and is situated in a small depression of the surface. A straight tracheal branch from the longitudinal trunk connects with each spiracle. Other tracheal branches leave the main trunks and extend to the various organs and tissues.

Numerous droplet-like haemocoelic inclusions (Fig. 12 *hi*), are observed in the advanced third instar larvae. These vary much in size but are always flattened and are either smoothly rounded or hexagonal if pressure is applied by crowding. The contents appear to be part granulate, part droplet in texture. They are contained by an extremely thin, colorless, transparent membrane. These probably represent at least a part of the storage of metabolic reserves which will be carried through the pupal stage into the adult.

The more mature larvae eat their way through the host eggs and if present in sufficient numbers have by the end of the stage devoured the entire contents of the ootheca. The chorion layers are frequently pulled away from the inside face of the capsule wall; double layers of egg shell made by adjoining host eggs are torn down when the parasite population is high. The removal of these darker egg shells allows direct observation of the late larvae through the capsule wall.

The mature larvae usually are found haphazardly distributed throughout the interior of the capsule. If a high population is developing within one egg case, there is a tendency for the larvae to align themselves vertically within the capsule; in this position they occupy much the same position as did the host eggs before them. The respiratory needs of these larger and more active larvae probably are met by diffusion through the seam; some aid, of doubtful quantity, might be expected from the oviposition punctures.

The meconium when voided consists of oily pellets (Fig. 14, *mp*) having a distinct membranous covering. These are colorless at first but become yellowish and opaque with age. They are sticky and adhere to each other and to the dissection instruments. Where crowding is not too pronounced, the meconial pellets are scattered at random over the oothecal wall. A concentration of the pellets on the posterior capsule wall may be found whenever the larvae are lined up toward the seam.

Prepupa. The last larval or prepupal integument is extremely thin, transparent, and colorless. It becomes widely separated from the inner tissue mass from which the pupa will be formed. The larval head is a round, somewhat flattened protuberance which appears to have been shoved forward. The mandibles and sclerotic arc surrounding the mouth are clearly visible. A distinctly lobed condition of the caudal segment indicates that the functional connection with the gut has been established. This was further verified by observing the passage of meconial pellets by one larva from a dissected capsule.

The head is the earliest to become evident and recognizable. Faintly translucent globes are seen in front of the pupal face and apparently evolve into the antennae. Other globular masses, seen from below, appear to be the forerunners of the mouthparts. The limb rudiments are distinguishable if viewed with the proper transmitted light. The lateral longitudinal abdominal line separating the dorsal and ventral plates, with indications of future segmentation showing, is visible through the prepupal integument covering the group of segments behind the thoracic region.

Body segmentation is much more evident at this stage, being visible as comparatively deep circular constrictions. The width of the space between constrictions varies from front to back. Three wide spaces take up about half the body length. The first is rounded in front and shows outlines of the pupal head being formed. The next two are evidently thoracic precursors; a deep interior constriction sets off the head from the thoracic region. The prothorax apparently is not indicated here as a separate segment, since there is no short segment immediately behind the head portion. The second and third wide segments then will form the pupal mesothoracic and metathoracic divisions. Six narrow circular divisions are found next after the second of the thoracic segments which are considerably wider dorsally than ventrally and are separated by relatively deep constrictions. The width of these six segments is subject to some variation as the result of the slow constrictive actions of the prepupa. These segments are succeeded first by a very short transverse dorsal plate not continuing down on the sides and then by a single long, tapered caudal segment. The latter tapers apically both dorsoventrally and laterally, with the termination being distinctly narrowed but blunt.

As the prepupal period progresses, definite, more closely spaced segmentation is observed in the thoracic region, especially across the dorsal surface. The ovipositor sheath becomes visible in side view, along with the more pronounced differentiation of the leg rudiments.

Pupa. A series of pupae measured during the late coloring-up period averaged 2 mm. in length and 1 mm. across at the widest point through the wing pads. Variations from this average were about a half millimeter either way for each dimension.

The pupa is pure white when first formed but color begins to appear in a few hours. The head, antennae, legs, and top and bottom thoracic regions are pigmented in about 24 hours. Full color is achieved in approximately 48 hours. The abdominal color is black except for intersegmental bands which remain grayish to light brown. The eyes become purplish red, the appendages brownish to black, and the thorax is metallic greenish on top. The head has this same color in all areas except the posterior vertex region and immediately

above the mouthparts; these small areas are reddish purple. All metallic colored areas of the head and scutum of the thorax are densely covered with minute circular impressions (i.e., shagreened). The scutellum is evenly but less densely punctate.

The pupal appendages are all free; the segmentation of all is complete and quite evident. The antennal scape is flattened and very broad while the segments of the flagellum are rounded and all of about the same length. The coxae are flattened, lie flat along the ventral surface, and are directed backward. All femora are reflexed upward and forward, with the femoro-tibial joints on a level with the wing-pad bases. An apical spur present on the mesothoracic legs increases in size as the pupa ages. In the newly formed pupa the antennal flagella lie between the front and middle legs, while the outer wing pad lies between the middle and hind tibiae. These leg parts closely parallel the posterior margins of the wing pads. The femur and tibia of the hind legs are often found tucked beneath the front wing pads of the advanced pupa, with the joint protruding above the wing margin. The tips of the hind tarsi may extend to or slightly beyond the apex of the abdomen.

Adult. The descriptions given by Compere and Gomes are adequate and no attempt to add to them will be made here. The following observations are of a more general nature and are intended only to be informational in nature.

The wasp when observed without magnification appears to be black overall with white on the antennae and a touch of gray on the wings. When the insect is sitting the wings are stacked one above the other and are held flat over the abdomen. In most specimens the wings extend beyond the tip of the abdomen by about one-third the wing length.

Under the microscope much of the blackness of the head and dorsal thoracic surface is found to be dark brown with metallic green reflections. The ventral thoracic and both abdominal surfaces are black. The prepectus is light rusty brown. A broad grayish-white band arcs across the fore wings. On the front margin this begins at or just beyond the end of the one vein and curves across to a point just beyond the anal angle on the posterior margin. This band is rather broad and is usually situated just above or slightly beyond the tip of the abdomen.

Considerable variation occurs in the coloration of the funicular segments of the antennae (Figs. 15 and 17). The distal segment is enlarged, flattened longitudinally, and invariably is black. Of the seven funicular segments preceding it, the first or pedicel segment is variable in color from totally black to grayish white; the lighter coloration begins apically and extends basally. Between the pedicel and the apical are six segments, the color of which may be (proceeding distally) two black and four white, three of each color, or four black and two white. In a long series of wasps examined, 13% had two white segments; 16% had three, and 71% had four. Of the total examined, 87% were females. These had 80% with four white segments, 20% with three, and none with only two. All males present in the series had only two white segments; they also were slightly smaller in body size. Gomes (1942) illustrates the male antenna as having two white segments.

Duration of Life History Stages

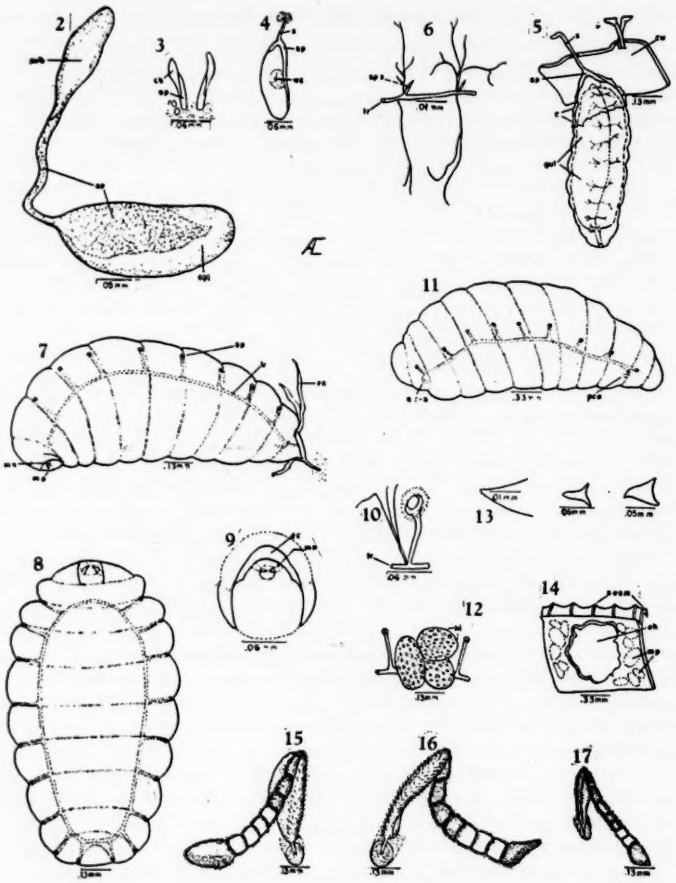
The development of this insect within the egg case of another makes impossible the direct observation and calculation of duration of stages. The times listed below were determined by dissecting oothecae in which the date of oviposition was known. It is realized that such data are somewhat approximate. The time spent in each stage of the life cycle was about as follows:

Egg stage—4 days
Larval stage—9 to 15 days (total)
1st instar—2 to 4 days
2nd instar—3 to 5 days
3rd instar—4 to 6 days
Prepupal stage—2 to 4 days
Pupal stage—12 to 14 days
Pre-emergence adult—3 to 4 days
Total (egg to emergence)—30 to 41 days

The end of the egg stage was determined with comparative accuracy because the chorion was pushed back and could be observed in wrinkled folds around the caudal portion of the newly hatched larva. The apperance of spiracles indicated within reasonable limits the end of the first instar. Actual hatching was watched in three dissected eggs; numerous chorionic ruptures were seen around the anterior region, after which the egg covering was gradually carried back over the body. The mandibles were continuously active.

The ends of the second larval instar and of succeeding stages were somewhat more difficult to determine. Since the second larval stage was ended by shedding an extremely thin layer of integument which was impossible to find later, this was perhaps the most difficult stage to ascertain. Changes in mandible size and coloration and apparent head widths were used as other indicators. The onset of the prepupal period was judged by the appearance of meconial pellets in the egg case; this, too, probably introduces some inaccuracy because of time lag. The last larval or prepupal integument is extremely thin and apparently is shed in fragments; no complete exuviae were ever found. The end of the pupal period generally was accounted for in the same manner. More accurate data on a few specimens were secured by placing prepupae on filter paper soaked with normal saline and incubating them in cotton-stoppered vials.

In addition to the limitations imposed by the nature of the integument, the wasps spend a pre-emergence period within the capsule. Almost invariably the adults which crawl out of the emergence holes have slender bodies with fully developed coloration and completely expanded wings. Since pre-emergence dissections have found active adults with the abdomens large, round, and showing distinctly gray intersegmental bands and with the wings still soft and crumpled, it is obvious that a hardening period normally takes place inside the roach egg case. The emergence hole evidently is not made until the wasps are at least very nearly ready to begin oviposition. With these limiting factors in mind, it appears that the actual pupal period of *C. merceti* reared at room temperatures is about 14 days. The pupal stage thus actually takes almost half of the entire non-adult portion of the life cycle, which is not



surprising in view of the apparently very low level of organologic development reached during the larval period.

Post-emergence adults normally lived three to five days. Various food materials were introduced into the cages but apparently had little effect on longevity. Withholding host eggs from the females did not result in longer life. Adult life was prolonged, however, by holding the vials in a refrigerator.

MATING

Mating activity was observed only once and that was of very brief duration. It is considered quite possible that copulation may take place before

emergence; this is based in part on the observation, through cleared areas of the capsule wall, of males with what appeared to be the copulatory organs fully distended and in a very active state.

EMERGENCE

The emergence hole (Fig. 14, *eh*) is made in the oothecal wall by the mandibles of the adult wasp. The holes are roughly circular to slightly oval in outline, with the greatest majority being more nearly oval. The edges are roughened by the activity of the insect, their irregular nature indicating more of a breaking than of a cutting action. The width of the holes averages .76 mm. with a range of .6 to .9 mm.

There is no set position on the ootheca from which emergence occurs. The governing factor appears to be one of position in relation to gravity rather than to any given part of the egg case. It was found that, in a large group of capsules observed in place after emergence had occurred, all such holes had been made through a dorsal wall of the egg case. Since the cases, because of their structural design more frequently lie on one side, the openings usually were in one of the side-walls. A few more holes were placed near the seam than elsewhere but no special significance is attached to this observation. It apparently happens because of the angle at which the oothecae are piled in the vial. A few emergences took place near the ends and on the back wall but these also apparently were the result of accident of position. In no case were holes made through the seam of the ootheca.

The meconial pellets remained plastered irregularly over the inner surface of the capsule at emergence. They were still soft to touch and apparently oily in texture. They gradually hardened as the opened egg case dried.

On a few occasions a small number of wasps developed in one portion of an egg case while roach nymphs continued to grow in other parts. The wasps usually were concentrated in one end and apparently did no harm to the roach nymphs, which were always the last to emerge.

EXPLANATION OF PLATE

Fig. 2. Ovarian egg of *C. merceti*.
Fig. 3. External stalks of two deposited eggs.
Fig. 4. Deposited egg, early whitespot stage.
Fig. 5. First instar larva top view, attached to stalk; two larvae were removed from stalks which remain.
Fig. 6. Close-up of branching tracheae at two spiracular stubs on tracheal trunk, 1st instar.
Fig. 7. Second instar larva, side view.
Fig. 8. Second instar larva, ventral view.
Fig. 9. "Face" of second instar larva, enlarged.
Fig. 10. One spiracle and associated tracheae, second instar.
Fig. 11. Third instar, side view.
Fig. 12. Close-up of haemocoelic bodies, two spiracles and portion of trachael trunk.
Fig. 13. Mandible of first, second, and third instar larvae (left to right).
Fig. 14. Portion of wall of ootheca showing emergence hole and meconial pellets inside.
Fig. 15. Antenna of female, four white segments.
Fig. 16. Antenna of female, three white segments.
Fig. 17. Antenna of male, two white segments.

SUMMARY

Comperia merceti (Gomes), an encyrtid parasite of the eggs of the Brown Banded roach, is well established in the Manhattan, Kansas, area. The wasp is minute, black, strongly attracted to light, and jumps flea-like when disturbed. Oviposition in roach oothecae of medium age occurs within a few hours of emergence. The parasite's eggs are placed inside the host eggs with a stalk connecting with the outside and presumably functioning in respiration. Externally the stalk is minute, white, and may be either straight or slightly bent. Inside, the stalk blends into a thickened cap which covers the end of the egg and which continues along one side as an aeroscopic plate. The eggs hatch in about four days. The first instar larvae have only one set of spiracles and these have a posterior location. Since the larva is retained in the base of the egg shell, the two spiracles are kept in direct contact with the aeroscopic plate. Second instar larvae develop additional spiracles and become independent of the plate but may remain nearby. Third instar larvae are more active, travel about inside the capsule, and usually clean up all host egg protoplasm.

The active larval stage lasts from nine to fifteen days. The prepupal condition persists for about two to four days and the pupal stage about fourteen. A pre-emergence adult period of some four days is spent inside the ootheca. Emergence is through a small oval hole chewed through an upper wall of the egg case.

Various habits as well as certain antennal color variations are discussed.

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BOOK NOTICE

Forest Entomology in Hawaii, by Otto H. Swezey. Bernice P. Bishop Museum special publication No. 44, x+266 pp., 32 figures, Honolulu, T. H.

Price: $4.00

This book is, as the subtitle states, "an annotated checklist of the insect faunas of the various components of the Hawaiian forests." This work summarizes Dr. Swezey's extensive studies of the entomology of the native forests covering a period of over 40 years. The arrangement is according to genera of plants concerned.

C. D. Michener

A REVISION OF THE GENUS *ACHOROTILE* IN AMERICA NORTH OF MEXICO (Homoptera:Fulgoridae, Delphacinae)[1]

R. H. BEAMER
Lawrence, Kansas

Achorotile Fieber

Frons, notum, and abdomen with numerous round pits; head about as broad as prothorax or slightly narrower, quite strongly carinate; vertex almost square, slightly broadening toward the front (in type species); frons with two median carinae parallel with sides and percurrent through apex of head; eyes moderately large, not deeply emarginate below; antennae short, terete, segment II at least twice as long as I. Pronotum quite long, lateral carinae curved outward behind eyes, not reaching hind margin. Calcar foliaceous, stout; hind tibiae bispinose. (After David L. Crawford, 1914, Proc. U.S. Nat. Mus. 46:578.) Type of genus: *Achorotile albosignata* Dahlbom.

Key to the species of *Achorotile*

1. Aedeagus sickle-shaped 2
   Aedeagus not sickle-shaped 3
2. Anal processes very broad, almost straight ..... *albosignata* Dahlbom
   Anal processes much narrower, distinctly curved ..... *coloradensis* n. sp.
3. Anal processes tapered to apices, almost straight 4
   Anal processes more or less avicephaliform at apices 6
4. Styles in ventrocaudal view pediform at apices 5
   Styles in ventrocaudal view not pediform ..... *stylata* n.sp.
5. Process on caudoventral margin of pygofer curved caudally at tip ..... *pediforma* n. sp.
   Process on caudoventral margin of pygofer nearly straight ..... *foveata* Spooner
6. Both margins of anal processes more or less sharp ..... *angulata* n.sp.
   One margin of anal processes rounded ..... *curvata* n.sp.

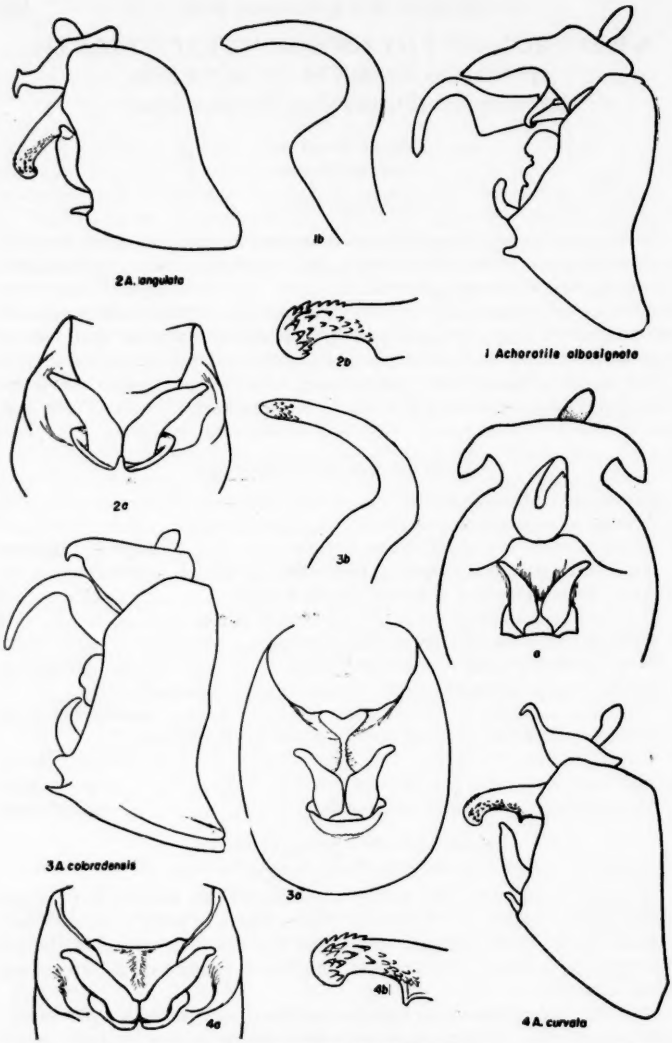
Achorotile albosignata (Dahlbom)

Delphax albosignata Dahlbom, 1849, Handl. Svenska Vet. Akad. 199.

Brachypterous form: This species is considered here because it is the type of the genus. Length ♂ 2.5 mm., ♀ 3mm. Males in general almost black, females much lighter. Thorax, vertex, and first two segments of dorsum of abdomen cream colored. Vertex, face, and lateral margins of abdominal segments with pits.

Internal male genitalia, in lateral view: Anal segment with a pair of very broad, anteriorly projecting processes; styles widest at base, slightly narrowing to rounded apices, curving gently from base to tip; pygofer with a blunted median spine in line with styles; aedeagus sickle-shaped on outer two-thirds.

[1] Contribution No. 875 from the Department of Entomology, University of Kansas. The drawings for this paper were made possible by a grant from the General Research Fund of the University of Kansas. They were prepared by Mr. L. J. Lipovsky.



EXPLANATION OF FIGURES

1. *Achorotile albosignata.* Lateral view of male genitalia. 1a. Caudoventral view of male capsule. 1b. Lateral view of aedeagus, enlarged.
2. *A. angulata.* Lateral view of male genitalia. 2a. Caudoventral view of male capsule. 2b. Lateral view of aedeagus, enlarged.
3. *A coloradensis.* Lateral view of male genitalia. 3a. Caudoventral view of male genital capsule. 3b. Lateral view of aedeagus, enlarged.
4. *A. curvata.* Lateral view of male genitalia. 4a. Caudoventral view of male genital capsule. 4b. Lateral view of aedeagus, enlarged.

The above description taken from three males and one female determined and sent to me by Doctor Frej Ossiannilsson of Sweden.

Achorotile angulata n.sp.

Brachypterous form: Resembling *A. curvata* but may be separated from this species by the avicephaliform tips to the anal processes. Length 2.5-3 mm.

Color: General color black to dark brown, dorsum of first two abdominal segments white, vertex and pronotum cream-colored.

Male internal genitalia: In lateral view shaft of aedeagus almost straight, apex enlarged, slightly curved ventrally, covered with retrorse teeth; anal processes with avicephaliform apices; medioventral process of pygofer straight, sides tapered to sharp point, about one-fourth as long as aedeagus. Styles in caudoventral view widest at base, gently narrowing to apices, slightly sinuate throughout.

Types: Holotype male, allotype ♀, 7 male and one female paratypes, Florissant, Colorado, June 6, 1949, R. H. Beamer. Types in the Snow Entomological Museum.

Achorotile coloradensis n.sp.

Brachypterous form: This is the only North American species with a sickle-shaped aedeagus like *Achorotile albosignata* known to date. It may be separated from this species by having narrow curved processes on the anal segment and a blunt process on the medioventral margin of the pygofer. Length 2.5-3 mm. Color somewhat lighter in general than in *A. albosignata.*

Male genitalia: In lateral view aedeagus sickle-shaped, the curve less than in *albosignata;* processes on anal segment, short and curved, process on medio ventral margin of pygofer sharp thorn-like, a rounded knob before curving, sharply pointed styles. Styles narrowed from base to apices.

Types: Holotype male, allotype female, and female paratype, Ouray, Colorado, July 15, 1937, R. H. Beamer. In the Snow Entomological Museum.

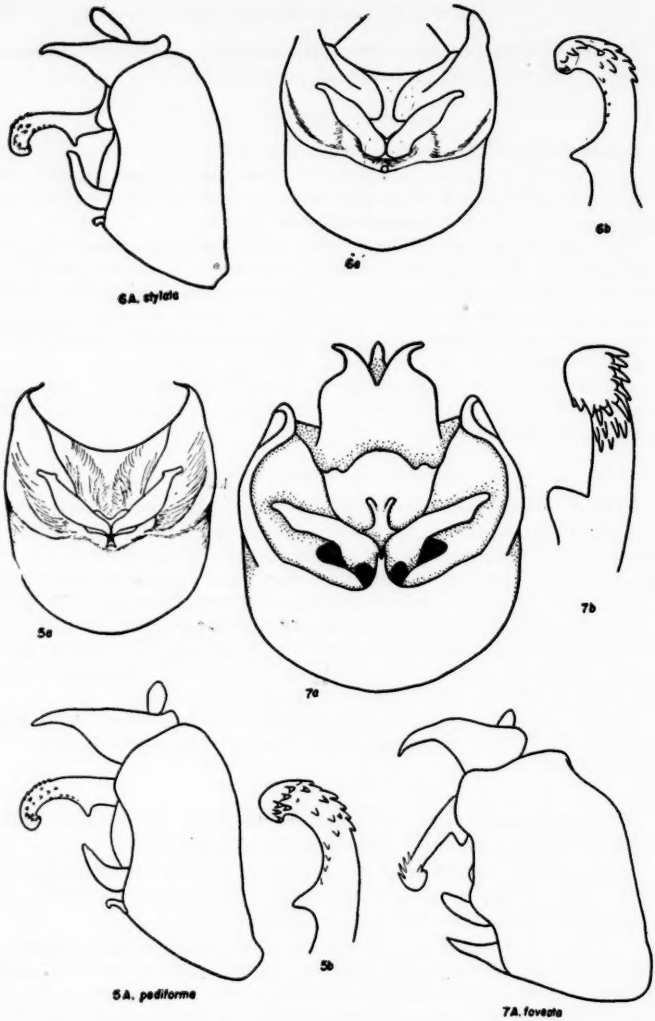
Achorotile curvata n.sp.

Brachypterous form: Resembling *A. foveata* but anal processes quite long and slender, bent ventrally at apices. Length 2.5 mm.

Color: Male abdomen black except dorsum of first two abdominal segments white, scutellum black, elytra dark brown, vertex and pronotum cream colored;female in general considerably lighter.

Genitalia of male: In lateral view, aedeagus almost straight, slightly enlarged at tip and bent ventrally, well covered with retrorse teeth, an angular tooth on ventral margin near middle, styles widest at base, evenly narrowed and curved dorsally to apices, slightly turned ventrally at extreme tip; caudomedian process of pygofer sinuate, sides almost parallel, about one-sixth as long as styles; anal processes long and narrow on outer half, bent ventrally at right angles at apices.

Types: Holotype male, allotype female, 23 ♂ and 14 ♀ paratypes, White Mts., Arizona, June 19, 1950, R. H. Beamer. Types in the Snow Entomological Museum.



EXPLANATION OF FIGURES

5. *A. pediforma.* Lateral view of male genitalia. 5a. Caudoventral view of male genital capsule. 5b. Lateral view of aedeagus, enlarged.
6. *A. stylata.* Lateral view of male genitalia. 6a. Caudoventral view of male genital capsule. 6b. Lateral view of aedeagus, enlarged.
7. *A. foveata.* Lateral view of male genitalia. 7a. Caudoventral view of male genital capsule. 7b. Lateral view of aedeagus, enlarged.

Achorotile pediforma n. sp.

Brachypterous form: Resembles *A. stylata* but easily separated from that species by the pediform apices of the styles.

Color: General color mostly dark, females lighter, elytra of males shining black, of females brown.

Internal male genitalia: In lateral view aedeagus curved caudally with retrorse teeth on outer third, median tooth on ventral margin prominent; anal processes large, almost straight, very slightly curved caudally on outer third; styles two-thirds as long as aedeagus, narrowed and curved dorsally; caudomedian process on pygofer almost one-fourth as long as style, curved caudally at tip with a prominent hook on ventral margin at apex. In caudoventral view styles distinctly pediform at apices.

Types: Holotype male, allotype female, and one pair of paratypes, Colokum Pass, Washington, July, 1949, R. H. Beamer. Types in the Snow Entomological Museum.

Achorotile stylata n. sp.

Brachypterous form: Resembling *A. foveata* Spooner but may be distinguished from it by shaft of aedeagus curved ventrally on outer third and medioventral process on pygofer very short with apex bent ventrally.

General color darker than in *A. foveata,* short-winged males shining black. Females lighter.

Male genitalia: In lateral view aedeagus curved ventrally on outer third with retrorse teeth over most of this area, with bluntly rounded ventral process near middle of ventral margin of pygofer; styles widest at base, narrowed evenly to apices; caudoventral process of aedeagus sharply angular, short; anal segment with processes almost straight, fairly slender apically.

Types: Holotype male, allotype female, and one pair of paratypes, Yellowstone National Park, Wyoming, July 12, 1939, D. J. and J. N. Knull.

Holotype and allotype in collection of Doctor J. N. Knull, one pair of paratypes in Snow Museum.

Achorotile foveata Spooner

Achorotile foveata Spooner, 1912, Can. Ent., 44:241.

This is the only species in this genus described to date from America. It was named from a macropterous female taken by Doctor J. C. Bradley on May 17, 1907, and is now in the collection of Cornell University at Ithaca, N. Y. So far I have found it impossible to tell females of the species of this genus apart. The only male from California before me is from Weaverville which is some distance north of San Francisco, while the type locality of this species is Felton, a few miles south of San Francisco. Until such time as males are at hand from Felton, I prefer to call this species *foveata.* It was collected by Dr. and Mrs. J. N. Knull at Weaverville, California, June 16, 1941, and is in Dr. Knull's collection.

FURTHER OBSERVATIONS ON BACTERIOLOGICAL STERILITY OF THE CHAMBER OF CYNIPID-INDUCED GALLS ON *QUERCUS GAMBELII* NUTT.*

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Introduction

The object of this paper is to present additional data in support of the conclusions presented in a previous report (Grundmann and Evans, 1952), viz., that bacteria are absent in both the larva and the gall chamber of cynipid wasps, and that the host plant (*Quercus gambelii* Nutt.) may have destroyed such foreign bacteria as may have been introduced with the egg at oviposition. The possibilty, however, that the culture media used did not provide essential growth substances was admitted. For this reason several additional media have been used to test for the presence of bacteria in two of the species of gall wasps used in the original study as well as in species not included previously. Attempts also were made to isolate bacteria from immature galls on the oak leaves as soon as they unfold in the early spring. The leaf buds break on April 25th or 26th and two or three days later the young galls appear. Galls are full-sized by the time the leaves stop growing.

The present study is one phase of the larger problem concerning causes of gall formation on leaves of scrub oak. If no bacteria are present even in very young galls, as our results lead us to believe, then bacteria can be eliminated as a factor in gall formation. Kostoff and Kendall (1929) reported that one of the factors in the formation of cynipid galls was that produced by unicellular microorganisms (bacteria) which they observed in the gall chamber in large numbers. They also stated that cynipid galls appear on *Quercus alba* L. and other species of oaks not as a result of one factor, but as a result of at least six factors, one of which was the effects produced by microorganisms. Kendall (1930) also suggests that microorganisms may play a part in the development of eriophyid galls on *Lyceum, Betula, Celtis,* and *Fraxinus.* In the last analysis, it seems reasonable that some single chemical substance or complex of chemical substances is responsible for initiating the formation of the gall. This active agent has not been identified. In galls produced by the crown-gall organism, *Phytomonas tumefaciens,* however, such an active substance has been recovered which appears to be heat labile and proteinaceous (Brown, 1947).

MATERIALS AND METHODS

Members of the family Cynipidae used in the experiments were as follows: *Cynips hirta undulata* (Gillette) Kinsey, *Callirhytis juvenca* Weld, *Plagiotrochus frequens* (Gillette) Kinsey, *Dishlocapsis rubens* (Gillette) Kinsey, and an *Andricus* sp. (a fall generation). *P. frequens* and *D. rubens* produce stem galls; the others cause leaf galls. The two types of immature galls studied

*This project was carried on with funds from the University of Utah Research Fund.

were vernal types formed by *Andricus pilula* Bassett, which were gathered early in spring as the leaf buds unfolded, and *Cynips hirta undulata* which were gathered on leaves as they appeared later in the spring. It is possible to obtain young galls of approximately the same age for study throughout the spring months by collecting them at progressively higher elevations. For every increase of 1000 feet in altitude, there is an average decrease of 3° C. in mean temperature.

The outer surface of the galls was sterilized by placing the galls, with a small portion of the attached leaf or bark, in either mercuric chloride solution (1:1000) or in 70% ethyl alcohol. Time of exposure in the sterilizing agents was three minutes in mercuric chloride and at least ten minutes in the alcohol solution. The intent in this procedure was to sterilize the outer surface of the gall without affecting the inner tissues of the gall and the insect within. The young galls were about one-half as resistant to penetration of the sterilizing agent as were the mature galls; it was sometimes difficult to determine if young larva within the gall had been injured, and considerable care was exercised during sterilization of these newly-formed galls to insure that they were not over-exposed. Ten minutes in mecuric chloride solution killed the larva inside the mature gall. The alcohol solution proved to be more satisfactory than the mercuric chloride solution for killing the surface bacteria.

The disinfected galls were opened with sterile needles. The use of a steroscopic microscope was required with small galls, particularly when immature. The insect within, whether it was larva, pupa, or adult, was gently removed with one of the sterile needles and dropped into nutrient media. The inside wall of the gall was carefully scraped and the scrapings also placed in nutrient media. Many larvae appeared to be dead when the gall was opened; usually these were discarded. Some, however, were tested in a manner similar to that employed with living insects to determine if bacteria were present and if they were possibly the cause of the death of the larvae.

Liquid media was used throughout the investigation. The media used were as follows: casein hydrolysate, soy hydrolysate, yeast hydrolysate, beef broth, liver fraction L, and a special nutrient medium for growing the crown-gall bacterium devised by McIntire, Peterson, and Riker (1942). The carbon and nitrogen sources in the crown-gall medium were sucrose, urea, and ammonium sulfate. The hydrolysates, the beef broth, and liver fraction L were dissolved in distilled water, and autoclaved; each had a concentration of 0.5%. These solutions were poured into sterile test tubes in 10 cc. amounts. The inoculated media was incubated at 27°C. for at least three weeks. All manipulations involving sterile solutions and operations on galls were carried out under a sterile hood irradiated with ultraviolet light.

The above procedure differed from that reported previously (Grundmann and Evans, 1952) in that the gall insects in the present experiments were not crushed, but rather were dropped whole into the nutrient media, and also in that no anaerobic techniques were employed. Our primary interest in this investigation was to determine the presence of microorganisms in the gall chamber and adhering to the body surface of the insect rather than in digestive tracts and tissues of the insects as attempted previously. It was felt that anaer-

obic procedures were unnecessary since the gall tissues and cavity are normally supplied with oxygen via the plant's vascular tissue.

When the experiments were terminated, all inoculated liquid media was streaked onto nutrient agar to which small amounts of the nutrient media had been added, and incubated for several days.

RESULTS AND DISCUSSION

The results indicate that, while it is possible that the microorganisms may be introduced into the leaf bud or stem tissue when the female wasp deposits its eggs, no bacteria appeared to be present in either immature or mature galls. This observation is supported by the work of a number of investigators studying the pathology of crown-gall tissues. Braun and White (1943) reported that secondary tumors of crown-gall showed bacteriological sterility, and DeRopp (1947) has shown that even primary galls on sunflower were sometimes free of bacteria. White (1945) has isolated bacteria-free crown-gall tissue from galls on *Vinca rosea* L. which had apparently been freed of bacteria by heat. Dean (1937) stated that neither bacteria nor fungal hyphae were present in Cuscuta-induced galls.

There is no doubt that, even though the actual gall-inciting principle has not yet been identified, it consists of some foreign material acting either directly or indirectly upon the host tissue and produced either by the insect larva during its development or by the secretions of the adult female that might be introduced at the time of oviposition. In the case of *Andricus pilula,* the gall develops rapidly to approximately its full size in three to four days, the growth paralleling the rapid cell division that produces leaf expansion from the bud. The larvae exhibit but little growth during this time and may not have emerged from the egg at all. In this case at least, it is thought that the stimulus to gall formation may be provided by substances introduced by the female during the previous fall when the ova were introduced into the dormant leaf tissues of the bud and that no gall-forming action occurs as long as no cell division takes place in the leaf. The substance introduced would be absorbed by the surrounding cells and become effective at a subsequent period of rapid cell division. As was noted in a study of tumor formation in crown-gall by Braun (1951), the tumor-forming substance was absorbed by cells and each division reduced the amount in each cell by half until its effectiveness in causing abnormal growth in the plant ceased.

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WASPS OF THE GENUS *POLISTES* IN CALIFORNIA AND ARIZONA (Hymenoptera: Vespidae)

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During a study of nearctic species of *Polistes,* I came across several interesting records and forms of these common social wasps. The principal purpose of the present paper, therefore, is to offer some of the new distributional data which have accumulated and to describe a new form from Arizona and California.

In addition to the material in my own collections, I have studied specimens from the following institutions: the American Museum of Natural History (AMNH), the Snow Entomological Museum of the University of Kansas (SEM), the California Insect Survey of the University of California (CIS), and the University of Arizona (UA). To those responsible for the care of this material, I express my deep gratitude for making the specimens available to me. Also, thanks are due the staff of the Department of Entomology, University of Kansas, for the numerous kindnesses extended to me while most of the research on *Polistes* was being conducted there. Thanks are particularly due, however, to Dr. Richard M. Bohart for the kindly advice and suggestions which he has offered from time to time.

Polistes major major Palisot de Beauvois

Polistes major Beauvois, 1818, Insectes recuellis en Afrique et en Amérique, p. 206.

SPECIMENS EXAMINED: 1 ♀, Sunnyside Canyon, Huachuca Mountains, Arizona, Aug. 9, 1940 (RRS); 1 ♂, Santa Catalina Mts., Arizona, Oct. 23, 1937 (R. A. Flock; UA).

This common tropical wasp is rarely encountered in the United States but is sometimes found in the mountains of western Arizona and at Brownsville, Texas. The female from Sunnyside Canyon is intermediate between the typical form and the subspecies *castaneicolor* Bequaert, and is most likely a color variant in the population of that form. All other specimens which I have seen from that area are *castaneicolor.* In a paper to be published elsewhere, a key to the color forms of *Polistes major* is given.

Polistes major castaneicolor Bequaert

Polistes major var. *castaneicolor* Bequaert, 1936, Ent. News, 47:12.

SPECIMENS EXAMINED: numerous females and males from the following Arizona counties: Pima, Pinal, Cochise, and Santa Cruz. I have also seen material of this subspecies from the states of Sonora and Chihuahua, Mexico.

Polistes major palmarum Bequaert

Polistes major var. *palmarum* Bequaert, 1936, Ent. News, 47:11.

SPECIMENS EXAMINED: numerous females and/or workers from Magnesia Canyon, Riverside Co., Calif., in the collection of the California Insect Survey.

From the standpoint of distribution *palmarum* is one of the rarer nearctic *Polistes,* but within its range, which is apparently confined to Riverside County, California, it seems to be rather common.

Polistes canadensis canadensis (Linné)

Vespa canadensis Linné, 1758, Systema Naturae, edition 10, 1:574.

SPECIMENS EXAMINED: 5 ♀ ♀, Tucson, Pima Co., Arizona, March, 1940 (J. J. duBois; RRS); 14 ♀ ♀, Atascosa Mountains, Arizona, Oct. 3, 1938 (UA).

This form of *canadensis* is rare in the nearctic region, barely entering the United States in southern Arizona. I have seen numerous specimens of the typical form from Mexico, and collected a single female at Cincuenta Siete, Baja California, at the flowers of *Prosopis glandulosa.*

Polistes canadensis navajoe Cresson

Polistes navajoe Cresson, 1868, Amer. Ent. Soc. Trans., 1:383.

This form is very common in Arizona and Mexico and is occasionally taken in Riverside County, California. It probably also is found in Imperial County as the author took several females of *navajoe* at Yuma, Arizona, very close to the California- Arizona border. These specimens were visiting the flowers of the palo verde, *Cercidium* species.

Polistes exclamans arizonensis, new subspecies.

Nearest the subspecies *louisianus* Bequaert, but differs by being somewhat more fully maculated and with yellow instead of ivory markings.

Female and worker: Structurally identical with nominotypical and other forms. Ground color of abdomen in most specimens dark brown, but varying from faded ferruginous to black, of head and thorax dark ferruginous. Chrome yellow to sulphur yellow as follows: Clypeus, except central ferruginous spot; inner orbits to ocular sinuses; triangular mark above and between antennal sockets; transverse line on vertex posteriorly; outer orbits to top of eyes; anterior and dorsal margins of pronotum; tegulae, except central spot; post-tegulae; spot beneath tegulae; linear mark on lower plate of mesepisternum; longitudinal stripe on metapleura; two longitudinal stripes on propodeum; membranous areas at abdominal insertions; postscutellum; scutellum anteriorly; very minute spots on fore coxae; apices of mid and hind femora; bases and apices of all tibiae; all tarsi entirely; nar-

row apical fasciae on three basal terga; occasionally also narrow fasciae on second and third sterna. Wings brownish, usually with strong violaceous reflections. Length to apex of second tergum, 9.5-13.0 mm; 13.0-15.5 mm.

Male: Very similar to the female, differing from the nominotypical male in the reduced maculi, violaceous wings, and darker ground color of the body.

Holotype: Female or worker (Snow Entomological Museum, No. 4634); Baboquivari Mts., Arizona, July 19, 1950 (L. D. Beamer). *Allotype:* Male (Snow Entomological Museum, No. 4634); Phoenix, Arizona, 1952 (no further data). Numerous paratypes of both sexes from the following localities in Arizona: Baboquivari Mts., Wickenburg, Arivaca, Sabino Canyon, Tucson, Phoenix, Walnut City, Mesa, Chandler, Yuma, and Wellton; California: Winterhaven, Rancho Santa Fe; Sonora: Guaymas, Hermosillo.

Paratypes have been placed in the collections of the University of Kansas, University of California at Berkeley and Davis, California Academy of Sciences, University of Arizona, the American Museum of Natural History, the United States National Museum, and of the author.

The following paratypes were also studied:

Arizona: 1 ♀ Tumacacori National Monument, Santa Cruz Co., July 20, 1948 (C. & P. Vaurie), 3 ♀ ♀, near Kits Peak, Baboquivari Mts., 32°0′ N, 111°36′W, about 3600 ft., August 7-9, 1916, 1 ♀, Kits Peak, Rincon, Baboquivari Mts., 31°57′N, 111°33′W, about 4050 ft., August 1-4, 1916 (American Museum of Natural History), 2 ♀ ♀, Phoenix, August 9, 1950 (R. S. Beal), 1 ♀ Tucson, Pima Co., August 13, 1950 (R. S. Beal) (University of California, Berkeley). *Sonora*: 1 ♀, Sonora, no further data, 11 ♀ ♀, Pitiquito, July 4, 1952 (C. & P. Vaurie), 19 ♀ ♀, Copete Mine, 30 kilo. E. Carbo, (F. C. Nicholas), 1 ♀, Pesqueira, 20 mi. NE Hermosillo, July 20, 1952 (C. & P. Vaurie) (American Museum). Most of these paratypes have been returned to their respective collections.

Additional new forms of this species will be described by the author in a paper to be published elsewhere.

Polistes apachus de Saussure

Polistes apachus de Saussure, 1857, Soc. Ent. France Ann. (3), 5:314.
Polistes texanus Cresson, 1872, Amer. Ent. Soc. Trans., 4:246.

SPECIMENS EXAMINED: numerous specimens of both sexes from the following states: California, Arizona, New Mexico, Texas, Kansas, Colorado, and Oklahoma.

This large wasp is one of the most common *Polistes* in California and Arizona. In California it extends at least as far north as the northern part of Stanislaus County.

Polistes flavus Cresson

Polistes flavus Cresson, 1868, Amer. Ent. Soc. Trans., 1:383.

This almost entirely sulphur-yellow wasp is very common in Arizona, but seems to be absent from California. Structurally, it is very similar to *apachus*, but since there are certain differences in the facial characters of the males, I shall regard it as a valid species for the present.

Polistes fuscatus aurifer de Saussre

Polistes aurifer Saussure, 1853, Etudes sur la famille de Vespides, 2:78.
Polistes anaheimensis Provancher, 1888, Addit. Corr. Faune Ent. Canada Hym., p. 423.
Polistes fuscatus var. *montanus* Bequaert, 1940, N. Y. Ent. Soc. Jour., 48:26. New Synonomy.

SPECIMENS EXAMINED: numerous specimens of both sexes from Washington, Oregon, Idaho, California, and Montana.

Through the courtesy of Mr. R. A. LeBaron, I have been able to study three colonies of *aurifer* collected at Coulee City, Washington. In all cases, the inhabitants of the colonies were almost equally divided between *aurifer* and the form which Bequaert described as *montanus*. I have also seen a great number of specimens of *aurifer* from the same localities in Montana where *montanus* occurs. I feel fully justified, therefore, in placing *montanus* in synonomy with *aurifer*.

In a recent note on *Polistes*, I tell of a nest of *Polistes* which was populated by two queens, one of *aurifer*, one of *apachus*. The two were apparently on good terms with one another and were actively contributing toward a future colony together. A more careful study of the habitat preferences of these two species leads me to believe that the nest originally belonged to the *aurifer*. The nest was placed behind a 3 x 6 inch rafter in a dark, secluded corner of a garage. In the Turlock area, where the nest was found, the competition between these two wasps is keen; *apachus* selects the more open sites, leaving *aurifer* to the darker, less preferable locations. Furthermore, the texture of the carton was predominantly similar to that of *aurifer* nests, being somewhat thinner, lighter in color, and more finely divided than is the case in *apachus* nests. However, there were patches of carton which were apparently added by the *apachus* queen, these patches being quite conspicuous by their darker color, thicker and coarser carton.

Polistes fuscatus centralis Hayward, typical form.

Polistes fuscatus var. *centralis* Hayward, 1933, Utah Acad. Sci. Proc., 10:143.

In the typical form, *Polistes fuscatus centralis* is a rather distinct and easily recognized wasp, bearing a very close resemblance to *P. hunteri californicus* R. Bohart. I have seen two females, one with a manuscript name provided by C. D. Duncan, from Arizona: Nitsi Canyon, July 23, 1916 and Safford, Nov. 14, 1951 (L. A. Carruth).

Polistes fuscatus centralis Hayward, xanthic form

In California, Arizona, and Baja California, this is by far the most common form of *centralis*, and may well be worthy of a subspecific rank of its own. This wasp, which is very common in the desert regions, bears a remarkable resemblance to *Polistes apachus* with which it is often confused.

In Baja California I collected this form in the cotton-fields where it preyed upon the several lepidopterous larvae which were damaging the plants. In some cases, the wasps were so numerous in the fields that they destroyed the caterpillar populations before insecticides could take effect.

Polistes fuscatus utahensis Hayward

Polistes fuscatus var. *utahensis* Hayward, 1933, Utah Acad. Sci. Proc., 10:142.

SPECIMENS EXAMINED: 1 ♀, Todd's Lodge, Oak Creek Canyon, Coco-

nino Co., Arizona, Oct. 3, 1948 (RRS); Williams, Arizona, 6800 ft., Aug. 8, 1934 (E. L. Bell; AMNH); 1 ♀, Sunset Crater, Flagstaff, Arizona, approx. 7000 ft., Aug. 18, 1934 (E. L. Bell; AMNH); 1 ♀, Whiteriver, Arizona, July 8-11, 1940 (Gertsch & Hook; AMNH); 2 ♂ ♂, Safford, Nov. 14, 1951 (L. A. Carruth; UA); 1 ♂, Huachuca, Oct. 15, 1938 (UA); 1 ♂, Atascosa Mt., Arizona, Oct. 3, 1938 (UA); 2 ♂ ♂, Ruby, Arizona, Nov. 22, 1940 (R. A. Flock; UA); 1 ♀, Supia, Havaisu Canyon, Grand Canyon, Arizona, 3500 ft., Aug. 2, 1934 (D. Rockefeller; AMNH).

Polistes fuscatus connectans Bequaert is apparently the melanic form of *utahensis*, although it is seemingly distinct and valid. More material of both must be studied before a definite idea of the relationship of the two can be formed.

Polistes hunteri californicus R. Bohart

Polistes anaheimensis auctorum, nec Provancher, 1888.
Polistes hunteri californicus R. Bohart, 1949, Pan-Pacific Ent., 25:101.

This is one of the most common *Polistes* in California and Arizona, but is most abundant in the former state. In Arizona *californicus* intergrades to a great extent with typical *hunteri*, making the exact status of lone specimens difficult to decide. Of a series of specimens from the state of Chihuahua, Mexico, approximately one-half are typical *hunteri*, one fourth are *californicus*, and the remaining one-fourth are intermediate between these two forms and the subspecies *neotropicus* Bequaert. I have also seen 1 female from 20 miles south of Culiacan, Sinaloa, May 1, 1949 (G. M. Bradt; AMNH). In my collection are three females of this form from San Bernardo, Rio Mayo, Sonora, taken on August 16, 1935.

Polistes hunteri hunteri Bequaert

Polistes fuscatus var. *hunteri* Bequaert, 1940, N. Y. Ent. Soc. Jour., 48:23.

I have seen numerous specimens of this form from Arizona, where it is subject to great variation. Arizona seems to be a point of convergence for the three forms *hunteri, neotropicus,* and *californicus,* so that specimens must often be placed rather arbitrarily. The populations of nests of this species which I have studied present the most remarkable range of variation that I have ever seen in any species of *Polistes*. This is particularly true of nest populations from the western and southern part of the range.

Polistes hunteri neotropicus Bequaert

Polites fuscatus var. *neotropicus* Bequaert, 1940, N. Y. Ent. Soc. Jour., vol. 48, p. 28.

The occurrence of this form of *hunteri* in Arizona is so sporadic that it would probably be better to refer the few specimens placed here to *californicus*. This is a common wasp in Central America, but individuals from Arizona colored like the Central American specimens are probably mere variants in the population of *californicus*.

NOTES ON THE LARVAE OF *URANOTAENIA SYNTHETA* (DIPTERA:CULICIDAE)[1]

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The mosquito *Uranotaenia syntheta* is a relatively new addition to the known species of mosquito so far as all its stages are concerned. The female was described by Dyar and Shannon (1924), the male by Dampf (1943) and the larva by Porter (1946). Until a few years ago it was known only from Texas in the United States, but it was recently reported from Oklahoma (Griffith, 1952).[2]

In 1950 the writer (Breland, 1950) redescribed the larva of this species from a series which allowed certain individual variations to be noted. At that time some variation was observed in the upper head hairs: they were double in most cases, but single at the base and forked in an occasional specimen. The objectives of the present paper are to point out additional recently discovered variations in the head hairs and to add a few biological notes.

At the present time little is known of the biology of this species. It is sometimes taken in fair numbers in light traps (Eads, Menzies and Ogden, 1951; Griffith, 1952) but large numbers of larvae are seldom collected. The writer (Breland, 1948, 1950) reported several collections of larvae from small depressions near a stream in Palmetto State Park near Luling, Texas. Since that time many collections have been made in this area, but until recently only an occasional additional larva of *U. syntheta* has been recovered.

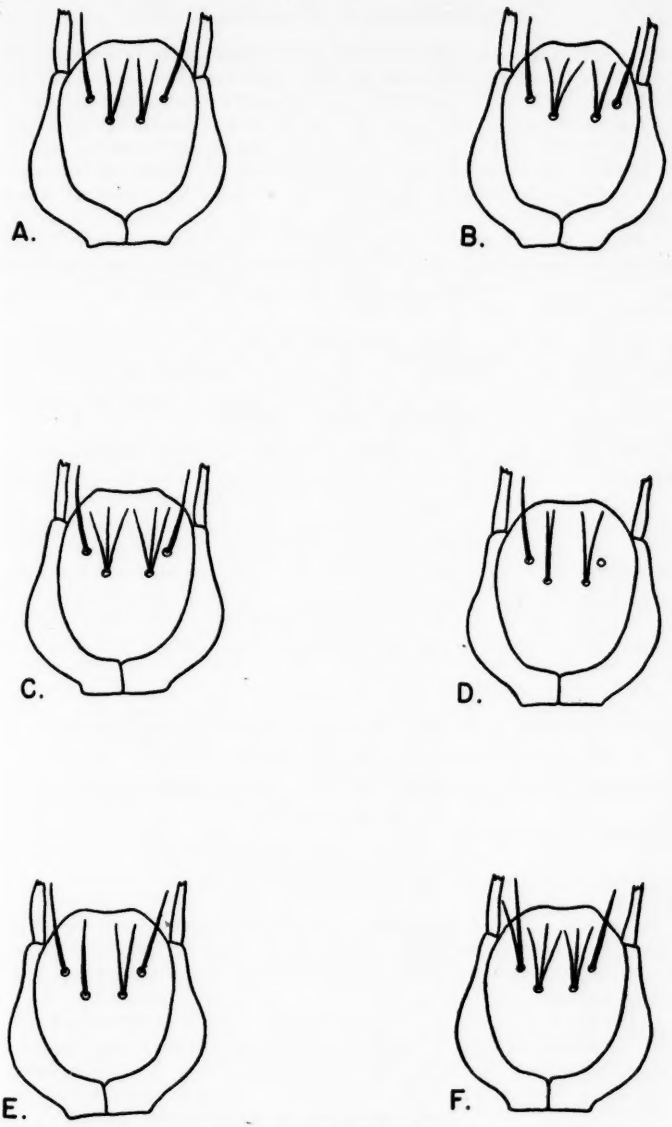
In the spring of 1953, many larvae of this species were found in a seepage area near the base of a bluff in Palmetto State Park. This spot is within a few hundred yards of the site where the larvae were first recovered. Associated species included *Culex thriambus* Dyar, *C. virgultus* Theobald and *C. tarsalis* Coquillett. Unfortunately, the occurrence of larval variations was not discovered until many of the larvae had pupated. Consequently, the number of larvae available for examination was not as great as might be desired.

Twenty seven larvae were used in this study, most of which were obtained from the seepage area noted above. Three of the larvae were collected from small pools near a stream. In fifteen of these specimens the upper head hairs are double, and the lower are single (Fig. A). The head hairs thus correspond to those of the larvae in the original and subsequent descriptions (Porter, 1946; Breland, 1950). In five of the larvae (Fig. B), one upper head hair is triple; both are triple in four specimens (Fig. C.). Figures D through F illustrate the head hairs in the three remaining larvae.

The presence of several variations in such a relatively small series indicates that the larvae of *U. syntheta* are more variable than formerly sup-

[1] This investigation was supported in part by a research grant, E-507, from the Microbiological Institute of the National Institutes of Health, Public Health Service; and by the University of Texas Research Institute. Drawings by Grace Hewitt.

[2] Recently reported from New Mexico: Mosquito News 14:30-31, 1954.



EXPLANATION OF PLATE

Diagrams of heads of larvae of *Uranotaenia syntheta* Dyar and Shannon showing variations in head hairs. Fig. A. Normal larva. Figure B-F. Types of variations found in a series of larvae.

posed, at least in some populations. The variations noted here would not, perhaps, be confusing to a worker with several larvae, who is familiar with the species. They might, however, cause considerable difficulty to the uninitiated with only one or two specimens. Brookman and Reeves (1953) suggest that *U. syntheta* and *U. anhydor* Dyar, a rare species from California, may be more closely related than previously suspected. The variations mentioned herein tend to support this suggestion since they overlap published descriptions of *U. anhydor*.

At the present state of our knowledge, it appears that *U. syntheta* prefers seepage puddles for egg deposition: near streams and in depressions where ground water accumulates. Workers interested in this species should concentrate on these types of collecting sites.

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NOTES ON NEARCTIC PHYMATIDAE II, (HEMIPTERA)

A new subspecies of *Macrocephalus prehensilis* (F.) from Florida

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I wish to express my gratitude to Dr. H. B. Hungerford of the University of Kansas for the privilege of studying a lot of unidentified *Macrocephalus* from the United States, deposited in the Snow Entomological Museum, University of Kansas.

The lot of 34 specimens contained only two species: *Macrocephalus uhleri* Handlirsch, 1898, (15 ♂ ♂ and 7 ♀ ♀, all from Arizona), and *Macrocephalus prehensilis* (F.), 1803, (the rest of the lot). Two ♂ ♂ from Alabama and 2 ♀ ♀ from Texas represented the typical form of *M. prehensilis* (F.), but 4 ♂ ♂ and 3 ♀ ♀ from Florida are distinctly smaller, having the connexivum relatively narrower in both sexes as compared with the specimens from Alabama and Texas of this lot and some others which I have from

Texas and Mississippi. Handlirsch, who has seen about 20 specimens from Carolina (the locality of the type) and Texas, among them the type of Fabricius, says: "Connexiva ganzrandig, auf dem zweiten und dritten Segmente night länger als breit, freiliegend . . ." (1897: 195). The specimens from Alabama and Texas, which I refer to the typical form, show the same character: the third (second visible) segment of the connexivum in the males has a ratio (exterior length to width) of 10:10 and the females of 11:12; in the specimens from Florida this ratio in the males is 9:6 to 9:7 and in the females 10:7 to 10:8, As all specimens from Florida, collected in different localities, have this character, we may consider them as a geographical subspecies and name it *Macrocephalus prehensilis* (F.) *minor* ssp. n.

Macrocephalus prehensilis (F.) belongs to the subgenus *Lophoscutus* Kormilev, 1951, having the aedeagus and the clasper of the type of *M. affinis* Guérin (1951:101).

Macrocephalus prehensilis minor ssp. n.

Male: Head longer than wide across the eyes (26:16.5); proportions of antennal joints (second to fourth), male—4 (4.5):5(3.5):14(7); female—4(4):5(3.5):11.5(6); (the figures in parentheses indicate the maximal width of the segment); pronotum wider than long (41:29), scutellum longer than wide (67:33).

Coloration in general is similar to the typical form, also somewhat variable; the males are darker, with head and pronotum brown, bordered with black; scutellum yellow with wide longitudinal black band, the base of the longitudinal carina is yellow, and sometimes on the yellow borders are dispersed sparse black points; connexivum yellow or pale brownish. The females are paler, the head and pronotum yellow-brown, sometimes pale reddish; scutellum yellow, basally pale testaceous; connexivum yellow. In life the females are probably greenish.

Total length of male: 4.7 mm., female: 5.1 mm. Width of pronotum of male; 1.6 mm., female: 1.9 mm., Width of abdomen of male: 2 mm., female: 2.3 mm.

Holotype: Male, Homestead, Florida, B. T. McDermott, VII-20-48, in the Snow Entomological Museum, University of Kansas, Lawrence.

Allotype: Female, same locality and date, R. H. Beamer, in same collection. *Paratypes*: 1 male, Sanford, Florida, J. D. Beamer, VIII-28-39, and one female, Homestead, Florida, in the same collection; 1 female, New Smyrne, Florida, B. T. McDermott, VII-29-48; 1 male, Homestead, Florida, E. L. Todd, VII-28-48; and 1 female, Homestead, Florida, R. H. Beamer, VII-20-48, in the collection of the author.

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